## REMARKS

In the last Office Action, the Examiner rejected claims 1-4 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,815,330 to Noguchi et al. ("Noguchi"). Additional art was cited of interest.

In accordance with this response, the specification has been suitably revised to correct informalities, provide antecedent basis for the claim language, and bring it into better conformance with U.S. practice. Original independent claims 1 and 3 have been amended to further patentably distinguish from the prior art of record. Original claims 1-4 have also been amended in formal respects to improve the wording and to bring them into better conformance with U.S. practice. New claims 5-20 have been added to provide a fuller scope of coverage. A new abstract which more clearly reflects the invention to which the amended and new claims are directed has been substituted for the original abstract.

Applicant requests reconsideration of his application in light of the following discussion.

## Brief Summary of the Invention

The present invention is directed to a method for manufacturing a semiconductor device, such as a MOS transistor.

Figs. 2A-2E show a conventional method for manufacturing a semiconductor device. As described in the specification (pgs. 1-3), a first oxide film 11 is formed on a surface of a silicon substrate 9 (Fig. 2A) and is then subjected to a nitriding treatment (Fig. 2B). As a result of the nitriding treatment, silicon oxynitride 12 is formed at an interface between the surface of the silicon substrate 9 and the first oxide film 11. The first oxide film 11 is then removed from a portion of the surface of the silicon substrate 9 using a hydrofluoric acid (Fig. 2C) for the purpose of preparing the portion of the surface of the silicon substrate so that a second oxide film 14 can be formed thereon (Fig. 2D).

However, the use of the hydrofluoric acid alone has been insufficient to completely remove the silicon oxynitride 12 formed at the interface between the portion of the surface of the silicon substrate 9 and the first oxide film 11. As a result, the silicon oxynitride 12 remains on the portion of the surface of the silicon substrate 9 from which the first oxide film 11 has been removed (see Fig. 2C). The remaining silicon oxynitride 12 acts as an inhibitor against oxidation during formation of the second oxide film 14 which is formed by thermal oxidation, thereby affecting the reliability of the second oxide film 14.

The present invention overcomes the drawbacks of the conventional art. Figs. 1A-1E show an embodiment of a method for manufacturing a semiconductor device according to the present invention embodied in the claims. A first silicon oxide film 3 is first formed on a semiconductor substrate 1 (Fig. 1A). The first silicon oxide film is then subjected to a nitriding treatment so that silicon oxynitride 4 forms at an interface between the semiconductor substrate 1 and the first silicon oxide film 3 (Fig. 1B). According to the present invention, the first silicon oxide film 3 is then completely removed from a portion of the semiconductor substrate 1 using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride 12 formed at the interface between the portion of the semiconductor substrate 1 and the first silicon oxide film 3 is also completely removed (Fig. 1C). A second silicon oxide film 6 is then formed on the portion of the semiconductor substrate 1 from which the first silicon oxide film 3 and the silicon oxynitride 12 have been completely removed (Fig. 1D).

By the foregoing manufacturing method according to the present invention, the silicon oxynitride which forms at the interface between the semiconductor substrate and the first silicon oxide film during the nitriding treatment is completely removed using the ammonia-hydrogen peroxide

solution. As a result, deterioration of the second silicon oxide film, which is subsequently formed on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride are completely removed, is effectively prevented.

**Traversal of Prior art Rejection**

Claims 1-4 were rejected under 35 U.S.C. §102(e) as being anticipated by Noguchi. Applicant respectfully traverses this rejection and submits that amended claims 1-4 recite subject matter which is not identically disclosed or described in Noguchi.

Amended independent claim 1 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film having a first thickness on a silicon substrate, nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film, removing the first silicon oxide film from a part of the silicon substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed, and forming a second silicon oxide film in

at least a portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride are removed, the second silicon oxide film having a second thickness different from the first thickness. No corresponding combination of steps is disclosed or described by Noguchi.

Noguchi discloses a method for manufacturing a semiconductor device involving the formation of copper (Cu) interconnections 46a-46e in an interconnection groove 40 of respective silicon oxide films 39 by CMP, and treating the surface of the silicon oxide films and Cu interconnections with a reducing plasma (see Abstract). However, Noguchi does not disclose or describe the combination of steps recited in amended claim 1 as set forth below.

Amended claim 1 requires the step of nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film. As recognized by the Examiner, Noguchi discloses a plasma treatment using ammonium or hydrogen after the Cu interconnections 46a-46e are formed in the grooves of the silicon oxide films 39 (col. 4, lines 1-10). However, the plasma treatment disclosed by Noguchi is completely different from and clearly does not correspond to a nitriding step in which silicon oxynitride forms at an interface between

the silicon substrate and the first silicon oxide film, as recited in amended claim 1.

Amended claim 1 further requires the step of removing the first silicon oxide film from a part of the silicon substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed. In col. 27, lines 1-24, Noguchi discloses a process for removing copper and oxide by CMP using a polishing liquid containing an organic acid and an oxidizing agent such as hydrogen peroxide or ammonium hydroxide. However, this process is completely different from the removing step recited in amended claim 1 which requires the use of an ammonia-hydrogen peroxide solution. Furthermore, Noguchi does not address at all the complete removal of silicon oxynitride at an interface between the silicon substrate and the first silicon oxide film, as required by amended claim 1.

Amended independent claim 3 also patentably distinguishes from Noguchi. More specifically, amended claim 3 requires the step of nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the

silicon substrate and the first silicon oxide film, removing the first silicon oxide film from a part of the silicon substrate, and washing the part of the silicon substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed. No corresponding combination of steps is disclosed or described by Noguchi as set forth above for amended independent claim 1.

In the absence of the foregoing disclosure recited in amended independent claims 1 and 3, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found".); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Noguchi for the reasons stated above. Furthermore, Noguchi does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Noguchi's manufacturing method to arrive at the claimed invention.

Claims 2 and 4 depend on and contain all of the limitations of amended independent claims 1 and 3, respectively, and, therefore, distinguish from Noguchi at least in the same manner as claims 1 and 3.

In view of the foregoing, applicant respectfully requests that the rejection of claims 1-4 under 35 U.S.C. §102(e) as being anticipated by Noguchi be withdrawn.

Applicant respectfully submits that new claims 5-20 also patentably distinguish from the prior art of record.

Claims 5-9 and 10-14 depend on and contain all of the limitations of amended claims 1 and 3, respectively, and, therefore, distinguish from the prior art of record at least in the same manner as claims 1 and 3.

Moreover, there are separate grounds for patentability of several of new dependent claims 5-14.

Claims 6 and 11 include the additional limitation that the second silicon oxide film comprises a gate oxide film. Claims 8 and 13 include the additional limitation that the portion of the first silicon oxide film which has not been removed during the removing step comprises a gate oxide film. No corresponding features are disclosed or suggested by the prior art of record. For example, Noguchi discloses a method for manufacturing a semiconductor device involving the formation of copper interconnections 46a-46e and silicon oxide films 39 (see Abstract and col. 14, lines 57-60). However, Noguchi does not deal at all with the formation of gate oxide films, as required by dependent claims 6 and 11.

New independent claim 15 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film on a semiconductor substrate, subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas so that silicon oxynitride forms at an interface between the semiconductor substrate and the first silicon oxide film, completely removing the first silicon oxide film and the corresponding silicon oxynitride from a portion of the semiconductor substrate, and forming a second silicon oxide film on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride have been

completely removed. No corresponding combination of steps are disclosed or suggested by the prior art of record.

For example, as set forth above for amended claims 1 and 13, Noguchi does not address at all the complete removal of silicon oxynitride formed at an interface between a semiconductor substrate and a first silicon oxide film, and further the complete removal of silicon oxynitride which is formed as a result of subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas, as required by independent claim 15.

Claims 16-20 depend on and contain all of the limitations of independent claim 15 and, therefore, distinguish from the prior art of record at least in the same manner as claim 15.

Moreover, there are separate grounds for patentability of several of new dependent claims 16-20.

Claim 16 includes the additional limitation that the removing step comprises a first step of completely removing the first silicon oxide film from the portion of the semiconductor substrate, and a second step of washing the portion of the semiconductor substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution to completely remove the silicon oxynitride formed at the

interface between the portion of the semiconductor substrate and the first silicon oxide film. No corresponding step is disclosed or suggested by the prior art of record. For example, while disclosing a process for removing copper and oxide by CMP using a polishing liquid containing an organic acid and an oxidizing agent such as hydrogen peroxide or ammonium hydroxide, Noguchi does not disclose or suggest the use of a chemical containing at least an ammonia-hydrogen peroxide solution, and further for the purpose of completely removing silicon oxynitride formed at an interface between a portion of the semiconductor substrate and the first silicon oxide film, as recited in dependent claim 16.

New claim 18 includes the additional limitation that the removing step comprises the step of removing the first silicon oxide film from the portion of the semiconductor substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the portion of the semiconductor substrate and the first silicon oxide film is completely removed. Again, no corresponding step is disclosed or suggested by the prior art of record.

New claim 20 includes the additional limitation that the semiconductor device comprises a MOS transistor, and that the first silicon oxide film comprises a gate oxide film of

the MOS transistor. No corresponding step is disclosed or suggested by the prior art of record as set forth above for amended dependent claims 8 and 13.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

ADAMS & WILKS
Attorneys for Applicant

By: _____
Bruce L. Adams
Reg. No. 25,386

50 Broadway
31st Floor
New York, NY 10004
(212) 809-3700

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March 7, 2005
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